Possible improvements in detriment calculation for the future

Introducing Publication 152

Webinar, 9 December 2022

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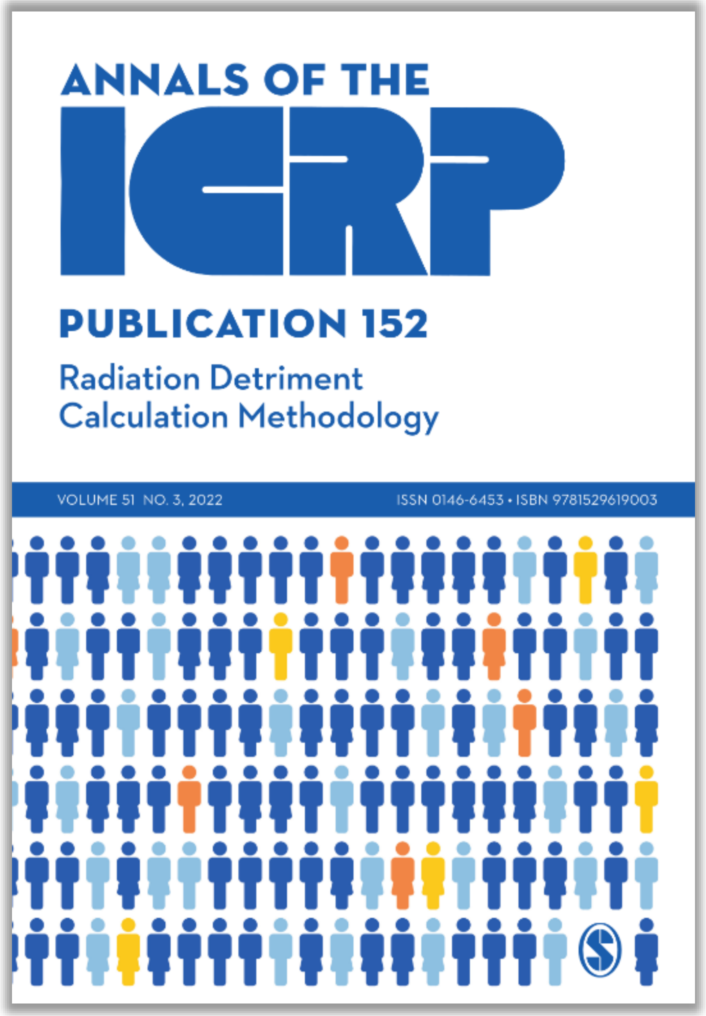
Chapters of P152

1. Introduction
2. Historical development
3. Calculation of radiation detriment
4. Sensitivity of radiation detriment calculation
5. Potential evolution
6. Summary and conclusions



Potential evolutions

Incorporate recent scientific findings

Update baseline statistics and demographic data

Refine adjustment for severity

Handling of variations

Insure transparency

Improve communication

Incorporate recent scientific findings

Cancer risk models

- Risk models for 11 organs derived from the A-Bomb survivors cohort (LSS) based on a follow-up to 1998
- Nominal risks for bone cancer and non-melanoma skin cancer taken from *Publication 60* (1991) and *Publication 59 (*1992)
- No specific risk models for the brain and salivary glands
- Risk models derived essentially from the LSS

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- **Update risk models**
- **Complete the list of radiation-induced cancers (brain, prostate…)**
- **Consider models derived from studies other than the LSS**

Incorporate recent scientific findings

Dose and Dose Rate Effectiveness Factor (DDREF)

- Application of a DDREF of 2 to reduce nominal risk coefficients at low dose and dose rate since *Publication 60* (1991)
- Large amount of new results from experimental studies and epidemiology accumulated during the last decades
- Possible today to analyse separately the effect of low doses (LDEF) and of dose rate (DREF)

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- **Conduct a thorough review of current knowledge**
- **Reflect on the relevance of applying a DDREF, on the possible values of this DDREF, on the potential alternative approaches, and on the impact on the calculation of the detriment**

Incorporate recent scientific findings

Heritable effects

- Risk of heritable effects based on results from animal experiments, assessed by the UNSCEAR in 2001
- Considered genetic risks, congenital abnormalities and multifactorial chronic diseases expressed up to the second generation
- The approach used to introduce heritable effects in the detriment calculation is not straightforward
- In the recent years, new findings have been obtained, including epigenetic inheritance

- **Update the review of the scientific literature on radiation and heritable effects**
- **Clarify the approach used to introduce heritable effects in the detriment calculation**

Incorporate recent scientific findings

Consideration of non-cancer effects

- In *Publication 118* (2012), the Commission proposed to classify circulatory diseases and cataracts as ‘tissue reactions’, with a threshold of 0.5 Gy
- In recent years, evidence has accumulated that some long-term non-cancer diseases may be induced at much lower doses than previously considered
- If these effects were to be included, a detailed calculation of lifetime risk appears highly challenging

  - **Update the review of the scientific literature on radiation and non-cancer diseases**
  - **Consider revising the classification of radiation-induced diseases**
  - **Assess the relevance and feasibility of including circulatory diseases and/or cataracts as stochastic effects, and estimate the potential impact on the calculation of the detriment**

Update baseline statistics and demographic data

- Two reference populations :
  - Asian (composite rates from Shanghai (China), Osaka, Hiroshima and Nagasaki (Japan))
  - Euro-American (composite rates from Sweden, United Kingdom and the Surveillance, Epidemiology and End Results (SEER) program of the US National Cancer Institute)
- Source for demographic data, mortality rates and cancer baseline rates
- Reference data correspond to the period 1993–1997

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- **Need for updated data**
- **Possible today to have a better representation of the world population**

Refine adjustment for severity

- Three cancer severity parameters
  - Lethality fractions per cancer site are derived from U.S. population data for the 1980–1985 and 1950–1970 periods (US DHHS, 1989). The same lethality fractions are used for males and females, the general population and workers
  - Relative estimates of years of life lost by cancer site are calculated relative to an average estimate for all solid cancers.
  - Adjustment for quality of life of cancer patients was based on judgment-based values

- **Need for updated parameters**
- **Improve transparency in the determination of these parameters**
- **Take into account variation between sex and regions**
- **Consider elaborated approaches such as disability-adjusted life years (DALY) to estimate and characterise the severity of cancers**

Handling of variations

- Age at exposure has a large impact on radiation detriment. In particular, exposure during childhood brings higher lifetime risks for most cancer sites compared to adult exposure
- Differences with sex are notable for some tissues, with the most extreme examples of the ovary and the breast
- Detriment values are averaged over risk model, region, sex and age
- The relative contribution of each cancer site to the global detriment varies with sex and age. These variations are not considered in the current W_T set

- **Calculate detriment separately for men and women, and for selected age categories**
- **Derive new sets of WT values for different categories of sex and age**
- **Average only at the last stage of the calculation, in order to provide a simple indicator for radiological protection management purpose**

Insure transparency

- Calculation of radiation detriment consists of many steps in which a wide range of information is processed, including risk models, health statistics along with various other parameters.
- Separation between science-based results and expert judgements at the different steps of the detriment calculation is not always explicit
- The make-up of radiation detriment is difficult to understand, even for radiation protection specialists
- The work of TG102 has illustrated the difficulty of reconstructing retrospectively the steps in the calculation of the detriment. It also identified errors in the calculation process

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- **Clarify the source information and document precisely the detriment calculation procedure to ensure transparency and traceability**
- **Apply quality control to the detriment calculation process**
- **Develop and share an open source code for the calculation of detriment**

Improve communication

- Uncertainties related to input information, lack of knowledge and the impact of underlying assumptions are poorly taken into account
- The calculation of the detriment is oriented towards the assessment of the overall impact of radiation on health. However, the values obtained are not easy to understand
- The detriment is a specific risk indicator for ionising radiation, and it is difficult to compare it with other commonly used health risk indices

- **Identify the main sources of uncertainties and a characterise their potential impact**
- **Better explain the quantification of radiation-induced risks and facilitate the interpretation of the detriment**

Conclusions

- **The concept of radiation detriment was first introduced in *Publication 26* (1977) and has been updated several times since then**

- **Several updates are needed to keep the detriment science-based**
- **Evolution in the calculation of the detriment should allow to better reflect variations of risks between sexes and age categories**
- **Careful consideration of the feasibility and pertinence of including specific non-cancer diseases in the calculation of the detriment has to be initiated**
- **Improvement must be made to insure the accuracy and transparency of the detriment calculation process**
- **An effort is needed to facilitate the interpretation of the radiation detriment**

Radiation detriment should

- be based on sound science,
- exercise prudence where uncertainty remains,
- not be overly complex, and
- be comprehensible

Make-up of radiation detriment reflects our wisdom as well as scientific knowledge and understanding

Keeping the ICRP recommendations fit for purpose

Journal of Radiological Protection

MEMORANDUM • OPEN ACCESS

Keeping the ICRP recommendations fit for purpose

C Clement[14,1], W Rühm[2], J Harrison[3,4], K Applegate[5], D Cool[6], C-M Larsson[7], C Cousins[1], J Lochard[8], S Bouffler[4], K Cho[9] + Show full author list

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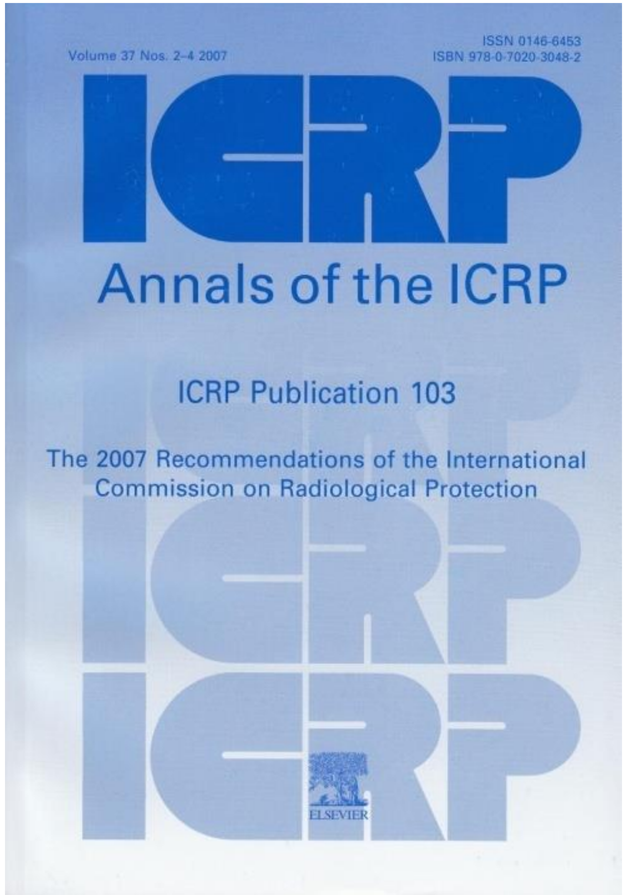
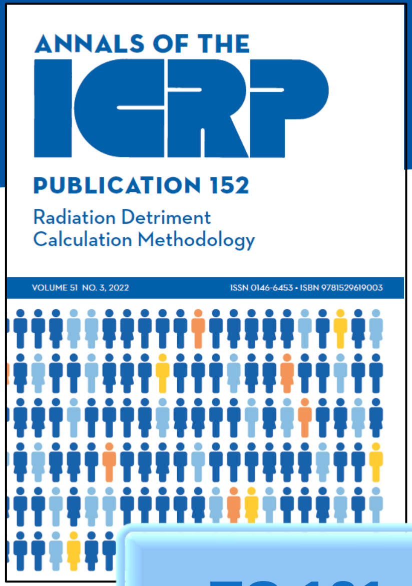
System review: the next decade



- Last general recommendations published in 2007
- Review and refinement needed
- Recognise gaps
- Consider needed updates
- Identify **building blocks**: essential work required for the next general recommendations

C1 program of work



TG 102 – Detriment Calculation

TG 91 – Dose and dose rate effects

TG 111 – Individual response

TG 119 – Circulatory diseases

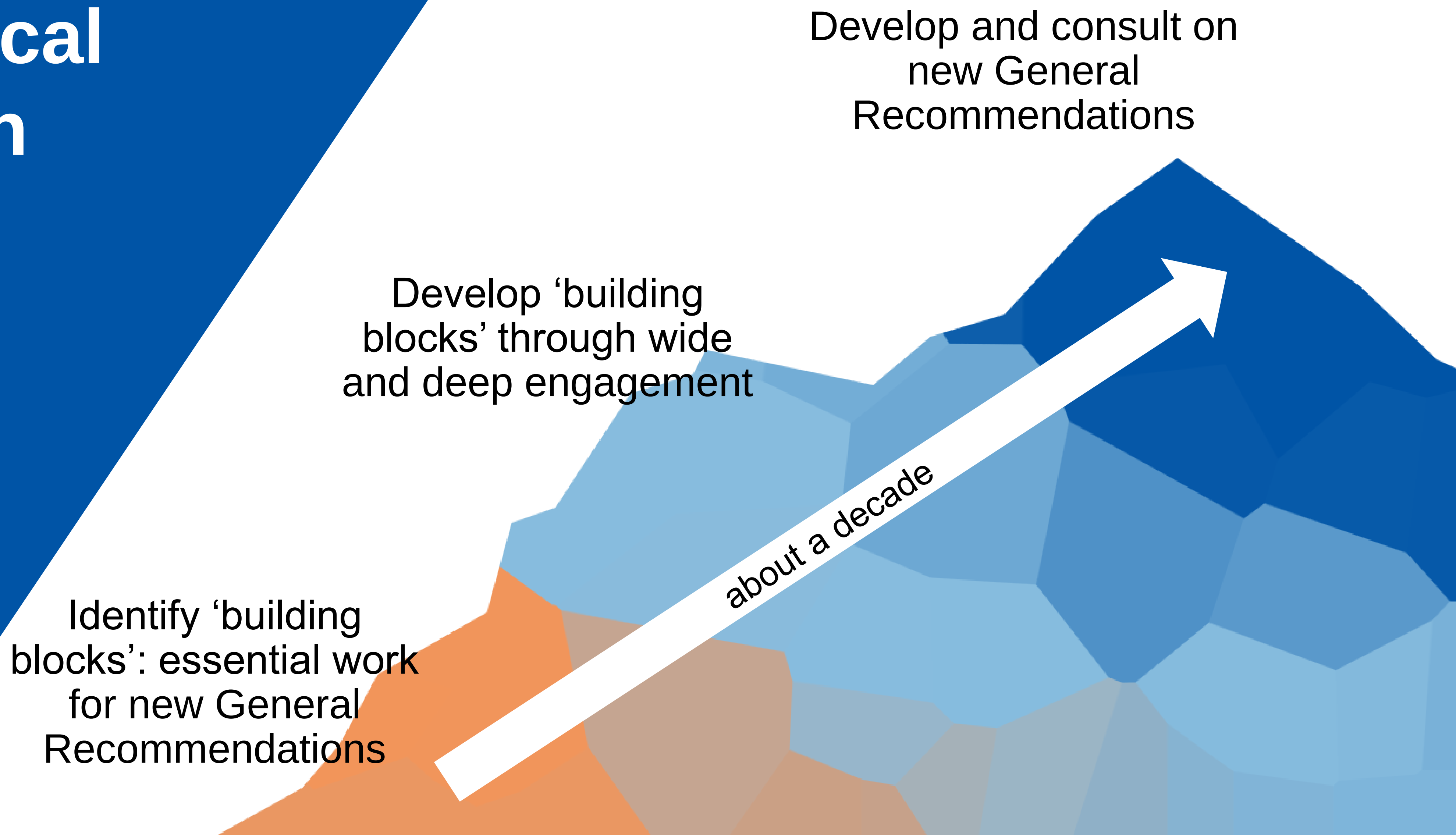
Radiation Detriment

TG 121 – Risks for next generations

TG 122 – Update of cancer detriment

TG 123 – Effects classification

Review & refinement of the System of Radiological Protection



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